

QUALITY OF PROCESSED APPLE PRODUCTS^{1,2}

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In looking at the variety or type of apple best suited for processing we should consider first what aspects of quality are judged most important by the buyer or consumer of these products. Rather different quality factors are involved depending on whether the raw product is to be used for slices or for sauce.

Sliced Apples

In a study of processed sliced apples, panels of industry specialists from the Appalachian area have evaluated samples, which we have prepared, to determine those quality grade factors which are most important. They were asked to disregard the defect aspects of the samples and to rate the other factors such as color, flavor and texture on the basis of 1-10. In these ratings 45 per cent out of 100 was assigned to the factor of color. Panel members indicated that a glossy bright slice was most desirable. They showed no discrimination between a Golden Delicious slice which had a bright golden hue or a Stayman slice which, in early harvest was white in color. This should help dispell the idea that those slices which are white fleshed are down graded in the market place.

Texture, which includes the factors of wholeness and firmness, was found to account for another 45 per cent of the overall grade. Each factor of texture was judged important but the panel members felt that firmness of slices was the most important individual phase of texture. Firmness is the quality attribute in which Appalachian apples have a definite competitive advantage over those produced in New England. This is mainly due to the York Imperial apple which does not soften perceptively even in long storages. McIntosh, Cortland, Red and Golden Delicious are soft varieties which have a firmness problem. Many of our packers in the Appalachian area can pack to buyer firmness specifications.

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- 2 A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research and Development Division of the Agricultural Research Service.

The other main attribute of quality flavor, received only a rating of 10 per cent of the overall grade. A survey indicated that flavor is not too important as long as it is typical of the variety or varieties used in the pack. In Maine it would appear that the flavor problem is not particularly critical, however, one must realize that other areas produce apple slices of good or excellent flavors.

In review it would appear that color and texture are the two most important quality attributes in apple slices and must be dealt with by using satisfactory raw stock as well as by careful processing techniques in the canning or freezing plant. Flavor does not appear critical as long as it is natural or normal. The McIntosh, your most important apple variety, appears to produce processed slices which are soft in texture and poor in color. These are serious problems for your processing industry.

Now that we have evaluated the factors of quality which are important in the processed product we must think about the raw stock available for processing. Varieties grown in New England are somewhat different than ours but I think that the principles of raw apple quality measurement are the same. Color of the flesh of raw slices can be measured by several instruments. One is the Hunter Color Difference meter. If you are interested in the chlorophyll loss in the apple as it ripens, a new instrument, called the Ratiospect, which measures the ratio of light absorption in the intact apple at two separate wave lengths 690 and 750 μ can be used. This instrument evaluates chlorophyll losses and is still in the development stage.

For apple quality determinations in the area of texture, which you will recall is quite important in the eyes of the packers, one may use the Magness-Taylor pressure tester with a 7/16" head. We find that the maximum pressure test values for the York and the Rhode Island Greening apple are 24-26 lbs. The minimum values for acceptable slices are from 13-15 lbs. Another instrument which may be used to determine the firmness of raw apple slices is the shear-press and here again the recommendations are dependent on whether the variety is a firm or a soft type. The maximum shear-press values for apple slices is between 750 and 800 lbs. force. The optimum shear-press value is 400 lbs. force and the minimum acceptable raw apple is about 200 lbs. force. Another means of determining the firmness characteristics of apples is a starch measurement. In our area the most ideal canned slices result from raw apples that have just about dissipated the starchy substances from their tissues. There is the possibility of harvesting apples too early to give an optimum slice firmness. York and Golden De-

licious slices from very early harvests have actually given a softer processed slice than those of later harvests. I believe that this is due to an incomplete development of the more rigid polysaccharides in the tissues and particularly an incomplete development of cellulose.

Although firmness of the raw apple stock is important we can improve it in processed slices by the addition of small amounts of calcium salts during the process. We have had excellent results with the use of calcium lactate. The York apple in our area rarely needs firming but in the McIntosh, Cortland, Red and Golden Delicious, calcium additions could be most helpful. The calcium solutions used are 0.25 to 0.5 per cent.

It is easy to measure the taste characteristics of a fruit slice, that is the sweetness or acidity of a slice. But this does not include the volatile apple essences which round out flavor in the product. Those apples which are below 10 per cent soluble solids generally do not make a very satisfactory processed slice. Raw apples, of course show a rather sharp decrease in total acidity as the fruit ripens or matures, changing from about .6 per cent to .3 per cent. It is possible to select an optimum acidity value somewhere along this range. Also, the pH increases as the fruit becomes less acid. The pH range for apples in our area is from pH 3.3 to pH 3.5. Perhaps the most useful evaluation of the taste characteristics of the raw fruit prior to processing is a sugar-acid ratio which is obtained by dividing the per cent acid value into the per cent soluble solids. Raw fruit sugar-acid ratio will range from 30 to 50 with the lower values being more tart and those with higher values much less tart and even overly sweet.

For evaluation of the internal constituents of apples for slices we are suggesting a three way test which best characterizes the important quality changes in the processed apple. They are (1) the shear-press, a firmness measurement; (2) per cent soluble solids, related to flavor and color; and (3) titratable acidity which is also related to flavor and color. We have placed these measurements together in multiple regression equations, and with Stayman, Golden Delicious, and Rome Beauty are able to predict the overall quality grade of processed slices from the raw fruit.

Table 1. Multiple Correlation Coefficients and Coefficients of Determination Between Overall Slice Scores and Certain Raw Product Quality Factors by Variety.

	R ²	R	Quality Factors		
Stayman	.658	.811	Shear-press	Titratable acidity	Soluble solids
Golden Delicious	.587	.766	Shear-press	"	"
Rome Beauty	.657	.810	Shear-press	"	"

Multiple regression equations for these varieties

Stayman overall grade slices = $-1.47 + .011SP + 5.11T.A. + .074SS$

Golden Delicious overall grade slices = $8.51 + .002SP + 4.74T.A. - .286SS$

Rome Beauty overall grade slices = $11.53 + .006SP + 4.75T.A. - .559SS$

Table 1 gives the summary of these relationships. The present grades which include size and external defect factors must be continued but for a healthy processed apple slice industry we believe that the internal quality characteristics of the raw apples must be also considered and we are suggesting the above system to evaluate these characteristics.

Applesauce

We must investigate the factors of sauce quality which are considered to be most important by the consumer. At Maryland we had a panel of packers go over a series of applesauce samples. They have evaluated the samples for color, flavor, texture and consistency. Then at a later date we had the same set of samples evaluated by a group of chain store buyers. It is interesting to compare the results of these two groups in terms of overall grade.

Table 2. Approximate Importance of Sauce Quality Factors When Related to Overall Quality.

	Industry	Chain store buyers
Color	46.6%	71.4%
Texture	7.2%	25.5%
Flavor	44.8%	0.2%
Consistency	1.4%	2.9%

Table 2 shows the relationship between the way the industry group evaluated samples of applesauce blends and the reaction of the chain store buyers. The chain store buyers placed a greater emphasis on the factors of color and texture while the industry group has placed a greater emphasis on the factors of color and flavor. In explaining the factors in applesauce quality, they were not critical of the actual color of the sauce but

red pigments from such varieties as Red Delicious or McIntosh will discolor the product.

Another new product is a sauce which contains bite-size apple pieces. Other fruits may also be added to this product. You must use new products to increase sales and to balance the natural weaknesses of the apple varieties you have available in your area.

Pie fillings or pie mixes are a new development in sliced products which have been popular for several years. Apple slices are mixed with starch, spices, sugar, citric acid or lemon juice and then heat processed under pressure as a low-acid product. These fillings have good consumer acceptance but have not reached their full potential in the #10 or gallon size line for bakeries.

Another new product, dehydro frozen apples is made by drying apple slices to about 50 per cent of their original weight and then freezing. Also semi-dried slices may be canned. This produces a very satisfactory dehydrocanned product.

Slices may be freeze dried, which is essentially freezing and at the same time reducing the moisture to about 2 per cent. Apple pieces have been freeze dried and used in cereals and other products.

Another interesting development is the explosive puffing of fruits. This technique developed at the Eastern Utilization Laboratory, removes the moisture to about 40 per cent, then the dried pieces are superheated under pressure in a closed vessel, pressure is suddenly released and a small percentage of the contained moisture is flashed into vapor creating a porous structure as it escapes. This makes attractive apple pieces for snacks, cereals or pies.

Summary

For a healthy processing industry in your state you must consider, at least for apple slice products, some of the internal constituents of the raw apple prior to processing. With your varieties such as McIntosh Cortland, Red and Golden Delicious you should consider very carefully pinpointing the internal quality attributes and relating these to the attributes of the processed slice. Also it should be possible with the use of calcium lactate or other calcium compounds to firm these varieties and make them competitive with slices from other areas in the country. In applesauce it is desirable to maintain specifications for buying the fruit from the standpoint of a maximum texture value and a minimum per cent soluble solids value. This will

were much more concerned whether the sauce was bright and glossy and had an attractive appearance. This comment was strongly emphasized by the chain store buyers. The chain store buyers in our area have put a premium on graininess in applesauce. We have developed a method here at Maryland which can be used to measure the actual grain characteristic of the sauce. We have found that the materials that lend themselves to texture also give a thick consistency. One of our former graduate students, Dr. Verner Toldby has worked on the consistency problem and feels that it is really two fairly independent phenomena; (1) the flow of the body of the sauce and (2) the liquid-solids separation or lyophoresis. These characteristics are directly related to the yield of applesauce. Raw fruit starches, pectins, and hemicelluloses have an influence on the viscosity of the liquids surrounding apple solids which in turn controls liquid-solids separation. Separation can be controlled by measures to increase liquid viscosity. Flow of the sauce body has been measured by the Adams Consistometer. We have found that values of 14 and above gives too heavy a consistency which is not desirable and that values of from 11 to 11.5 give sauce with an optimum amount of flow. Nine is starting to be too thin and samples which have values of 7 are much too thin. Readings at the filler bowl in the factory using hot sauce are generally 2 or 3 increments lower than those after the sauce has been on the shelf for several months.

Our work has shown that it is quite difficult to relate internal factors of the raw apple to sauce quality because of the many steps that take place in sauce manufacture. We suggest that in buying raw apples for sauce, the maximum firmness levels should be set at about 700-750 lbs. force for the shear-press and for 24-25 lbs. per sq. in. for the Magness-Taylor pressure tester. Also that a minimum soluble solids reading of 10 per cent should be specified of all apples going into sauce. A quick starch test could be used to predict the liquid-solids separation of the final sauce. A color measurement showing chlorophyll changes would be an excellent way to predict the gloss or the brightness characteristics of the final sauce.

New Products

In the area of new apple products we find some rather interesting developments. One is a pureed berry or other fruit added to applesauce to improve acceptability and sales. You are probably most familiar with appleberry sauce, a combination of red raspberry puree and applesauce. Packers add about 5-10 per cent of a strongly flavored fruit to the applesauce. This is a great help in thin white sauces like Cortland or in sauces where

allow your processor to maintain a high quality applesauce in the face of competition from New York State, Appalachia and even the West Coast. Studies of the quality attributes of processed slices or sauce show that color is of major importance and should receive a considerable amount of emphasis in the selection of your varieties for future planting in the state. Texture another aspect of quality, is also extremely important. I believe that in the New England area you must consider a variety which is firm and remains so in storage. Such a variety will contribute to both an excellent slice product and also a grainy type applesauce. As far as flavor is concerned New England is equally competitive with other areas in the country and has no problem in this facet of quality.

There are a number of new products which are coming on the market and are being widely accepted by consumers and I think that they should be used to offset any disadvantages which certain varieties in your section show when processed. Fruit purees for example, could be used to add a distinctive and attractive color to the product and also add certain textural characteristics which would be quite desirable. I think that you and your industry need to be fully aware of the various new techniques in processing, such as dehydrofreezing, dehydrocanning, freeze drying, explosive puffing and also the many new products so that the Maine apple industry can remain competitive over the long term.